Urban Household Demand for Fresh Fruits and Vegetables in Thailand

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Abstract Food systems are undergoing profound changes in developing countries, particularly on fresh produce with specific quality and safety attributes. An understanding of the demand patterns and their underlying determinants are important in designing food policies and generating information for local supply actors. The disaggregate demand parameters for fresh fruits & vegetables that have different product and process attributes were estimated by using the two-stage budgeting framework. The methodology accounted for censored data. The analysis is based on cross-sectional data of 300 households in Bangkok and 200 households in urban areas of Chiang Mai in 2007. The trend in domestic demand for fresh fruits & vegetables is towards an emphasis on safety, quality and convenience. Economic development, along with higher household incomes and educational levels of consumers, contribute to this tendency. Households are becoming more price responsive to fresh produce from modern supply chain sectors. The entire food sector should adapt to changes in consumers' preferences. Traditional retailers should create customer trust by adopting safety and quality standards and upgrading the quality attributes of fresh produce. Modern retailers should sustain own reputation and improve product lines by adopting premium standards. Policies and programs that foster income growth along with better education will spur demand for better quality products and lead to diversification in diets. The government should encourage the development and adoption of credible standards and product and process certification schemes. An information campaign to educate consumers on food safety and quality would expand the market for fresh produce and benefit farmers.

Keywords: fruit, vegetable, demand elasticity, food safety, almost ideal demand system

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อุปสงค์การบริโภคผักและผลไม้ของครัวเรือนไทยในเขตเมือง

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ฮอยเกอร์ ซีเบ็น ภาควิชาเศรษฐศาสตร์เกษตรและการพัฒนาชนบท มหาวิทยาลัยกอตติงเกน เมืองกอตติงเกน สหพันธ์สาธารณรัฐเยอรมัน
สมพร อิศวิลานนท์ สถาบันคลังสมองของชาติ

บทคัดย่อ ระบบสินค้าอาหารเปลี่ยนแปลงไปอย่างรวดเร็วในประเทศกำลังพัฒนา โดยเฉพาะอย่างยิ่งในด้านคุณภาพและความปลอดภัยของอาหารสด การเข้าใจรูปแบบอุปสงค์การบริโภคและปัจจัยแฝงนับเป็นองค์ความรู้สำคัญที่จะช่วยกำหนดนโยบายอาหาร และเป็นข้อมูลสำคัญต่อผู้ผลิตและผู้จำหน่ายในประเทศ การศึกษาครั้งนี้ประมาณค่าสัมประสิทธิ์ของอุปสงค์การบริโภคผักและผลไม้สด จำแนกตามคุณลักษณะของผลผลิตและกระบวนการผลิต โดยใช้กรอบแนวคิดการจัดสรรงบประมาณแบบสองขั้นตอน การวิเคราะห์อาศัยข้อมูลสำรวจครัวเรือนในกรุงเทพฯ และเขตเมืองจังหวัดเชียงใหม่ 300 และ 200 ครัวเรือน ตามลำดับในช่วง พ.ศ. 2550 แนวโน้มการบริโภคผักและผลไม้สดในเขตเมืองเน้นคุณภาพ ความปลอดภัย และความสะดวกสบายในการบริโภคมากขึ้น แนวโน้มนี้สอดคล้องกับฐานะทางเศรษฐกิจและรายได้ของครัวเรือน ตลอดจนระดับการศึกษาของผู้บริโภคที่สูงขึ้น ปริมาณการบริโภคผักและผลไม้สดที่มาจากโซ่อุปทานสมัยใหม่ของครัวเรือนมีการตอบสนองต่อราคาค่อนข้างสูง ภาคส่วนที่เกี่ยวข้องควรปรับตัวต่อการเปลี่ยนแปลงความพึงพอใจของผู้บริโภค ร้านค้าปลีกแบบดั้งเดิมควรสร้างความเชื่อมั่นให้กับผู้บริโภคโดยสร้างมาตรฐานคุณภาพและความปลอดภัยของผลผลิต ร้านค้าปลีกสมัยใหม่ควรรักษามาตรฐานที่มีอยู่และเพิ่มประสิทธิภาพการผลิตโดยนำมาตรฐานขั้นสูงมาปรับใช้ นโยบายและโครงการต่างๆ ที่ช่วยเพิ่มรายได้และระดับการศึกษาของครัวเรือน จะไปกระตุ้นการบริโภคสินค้าที่มีคุณภาพและเพิ่มความหลากหลายในการบริโภค รัฐควรสนับสนุนการพัฒนาและการใช้มาตรฐานที่น่าเชื่อถือ รวมถึงระบบการรับรองผลิตภัณฑ์และกระบวนการผลิต การรณรงค์ให้ข้อมูลแก่ผู้บริโภคเรื่องอาหารคุณภาพและปลอดภัยจะช่วยขยายตลาดสินค้ากลุ่มดังกล่าว และจะเอื้อประโยชน์ต่อเกษตรกรผู้ผลิตต่อไป

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Introduction

Rising incomes, urbanization and modern lifestyles have led to increasing demand for high-value food commodities in developing countries. The products are typically perishable and possess specific high-value attributes sold through specialized markets. These can include fruits, vegetables, livestock and dairy products (Gulati *et al.,* 2005; Weinberger and Lumpkin, 2006) The demand for fresh products with specific quality and safety attributes has induced a transformation of national and international food markets (Pingali, 2007). In this context, supply side actors face challenges to respond efficiently to new customer demand and meet specific new market requirements. In many developing countries, adaptation to the changes in demand patterns is more easily met by imports (Reardon *et al.,* 2003). It is therefore important for the country's supply chain actors to know and understand the shifts in demand patterns and the underlying determinants of the changes so that they can more effectively take advantage of and benefit more from new demand patterns.

Theoretically, the structure of consumption behavior can be reflected by the demand responsiveness to the change of income and prices and the effect of other individual characteristics. As yet, only a few studies have dealt with demand for high value food products disaggregated by attributes (Mergenthaler, Weinberger, and Qaim, 2009; Wang, Mao, and Gale, 2008; Rodriguez *et al.,* 2002). Studies on food demand in Thailand focused on demand analyses for highly aggregated fruits & vegetables, which cannot provide the necessary degree of detail (Schmidt and Isvilanonda, 2004). The previous studies also limited at the Engel curve and failed to consider the censoring issue. These limitations made the studies not fully consistent with economic theory. We add to this literature by using comprehensive data of urban households in Thailand for the estimation of the disaggregate demand parameter of fresh fruits & vegetables (FFV). The Linear Almost Ideal Demand System (LAIDS) (Deaton and Muellbauer, 1980b) is constructed in a two-stage demand system by incorporating a demographic translating function. Two-step estimators proposed by Shonkwiler and Yen (1999) are employed to account for data subject to censoring because of zero consumption by households.

In this study, the disaggregate product attributes of fresh fruits & vegetables comprised "safety and quality indications" with emphasis on formal labels. A second attribute is "place of purchase" focused on modern retailers as these are the main outlets that usually offer better quality

food and more shopping convenience. The third is "minimally processed" as a special convenience attribute which allows consumers to save time on food preparation. The analysis builds on a data set of 500 households from Bangkok and Chiang Mai urban areas representing consumers living in the capital city and the largest city in the northern region of Thailand. The paper proceeds as follows: Section 2 presents insights on emerging supply chain-related attributes; Section 3 describes the methodology; Section 4 presents the results; and Section 5 contains the conclusion and policy recommendations.

The Emerging Supply Chain Related Attributes in Thailand

Fruits and vegetables are high-value agricultural products that have a significant influence on marketing channels and small-scale farmers (Gulati *et al.,* 2005). The shares of these fresh produce have become much more important than traditional agricultural crops; they also tend to have different trade patterns (Aksoy, 2005). Practically, the structural change in fruit and vegetable production is caused by shifts in consumer demand in domestic and international markets. Consumers are increasingly concerned with food safety and quality. The diversification of fresh produce with specific quality attributes is a challenge for supply side actors to increase their returns from value addition. Food with specific quality attributes can increase the earning potential of the agricultural sector, especially farmers (Birthal, Joshi, and Gulati, 2005; Eaton and Sheperd, 2001). However, quality is not only intrinsic to the product but also involves the characteristics of production and distribution processes (Trienekens and Zuurbier, 2008).

As safety is a credence attribute, the identification of products needs to be preserved throughout all levels of the food chains. Food producers and retailers must learn to supply safe products and defend their interest in transparent and equivalent standards (Unnevehr, 2000). On top of the public regulations, the growing role of private food safety and quality standards has been introduced into supply chains (Henson and Reardon, 2005). Both tend to be increasingly important for consumers' judgments to purchase fresh produce (Grunert, 2005). In Thailand, various schemes of certification and branding exist that inform consumers of the production processes, safety and quality levels of products. A survey on population health care behavior revealed that 64 percent of consumers use the "food safety" sign of the Ministry of Health as an indicator of preferable food products (National Statistical Office, 2005). About 40 percent of interviewed consumers in urban

areas knew about and purchased vegetables that were certified and sold under the logo of DOA (hygienic vegetables, pesticide-safe vegetables) and 25 percent for products certified by DOAE (pesticide-safe vegetables); and almost 75 percent of all consumers knew about and purchased products certified by the Royal Project Foundation with the "Doi Kham" brand (Vanit-Anunchai, 2006). A small number of private producers and retailers ie. Aden, Walter and Doctor's Vegetable are currently using their own logos besides the government certificates. For all types of formal labels, certain consumer groups are normally targeted, particularly people who have a high willingness to pay for quality and safety attributes.

The growing demand for food products with safety, quality and other attributes has spurred modern retail outlets, such as supermarkets, into devising strategies to meet the demand. Following a regional trend in Southeast Asia, the importance of modern retail outlets in Thailand is growing rapidly (Weinberger and Lumpkin, 2006). Modern retail formats have some competitive advantages over traditional markets, the two important ones being convenience and product quality. They have implemented strategies to further upgrade product and signal some kind of quality to consumer by attaching a label or brand name, and offer a wide variety of products (Schipmann, 2010; USDA, 2004; Boselie, Henson, and Weatherspoon, 2003). Tokrisna (2006) found that the share of modern retailers rose from 26 percent in 1997 to 53 percent in 2001, while the share of traditional retailers declined from 74 to 47 percent in the same period. Modern retailers have reached all socio-economic levels of society and have especially penetrated the higher educated and younger consumer groups (Gorton, Sauer, and Supatpongkul, 2009). Furthermore, the supply of fresh-cut produce has increased in traditional markets and supermarkets (Rattanapanone, Chongsawat, and Soungsuda, 2000), indicating the growing demand for these product groups. The improving education standards and more disposable income of urban Thai consumers have led to an increasing desire for convenient fresh products especially in large cities such as Bangkok (Kanlayanarat and McGlasson, 2003). As such minimally processed fresh fruits & vegetables that have been processes, ie. washed, peeled and cut to increase their functionality can be an option for supply side actors to differentiate products and scale up prices.

In order to meet new demands from changing food preference, the knowledge of disaggregate demand elasticities and projected demand are required to help national supply chain actors adapt efficiently to changes in consumers' preferences as the economy develops and

lifestyles change. Guidelines from such understanding would inform policy decisions aimed at promoting the development of these markets to benefit local food producers and traders.

Concept and Method

The common approach to assess consumer behavior is to use the concept of separable preference by stepwise budgeting. This study utilized a two-stage budgeting model with a utility tree, illustrated in Figure 1. At the core of two-stage budgeting is the assumption of weak separability, that is, preferences for items within group are independent of items in another group (Deaton and Muellbauer, 1980a).
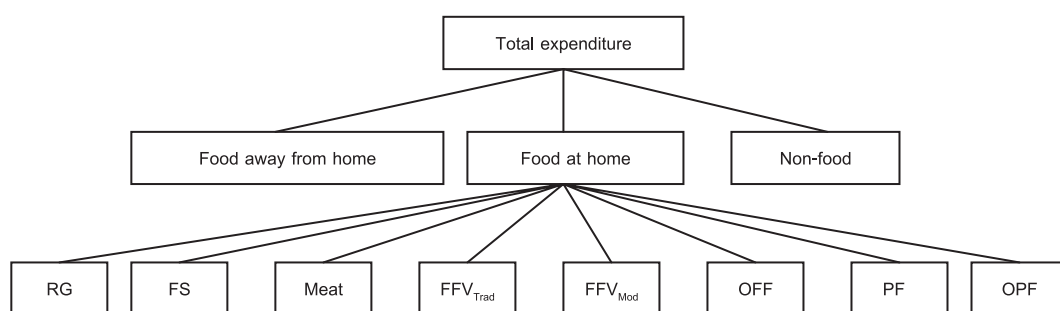

Figure 1 Utility tree of two-stages budgeting for disaggregate demand

Note: FFV_{Trad} and FFV_{Mod} are fresh fruits & vegetables from traditional and modern supply sectors, respectively.

It was assumed that households allocate total expenditure first to a broad group, namely, food away from home (FAFH), food at home (FAH)[1] and non-food (NF). At this stage, a Working-Leser model is employed to derive group expenditure elasticity in the absence of price information. Then, food at home products captured in the household survey are aggregated into 7 food commodity groups at the second stage. The 7 food groups are fresh fruits & vegetables (FFV), rice & glutinous rice (RG), meat, fish & seafood (FS), other fresh food (OFF), preserved fruits & vegetables (PFV), and other preserved food (OPF). Considering the disaggregate items, the aggregate FFV is replaced by sub-categories (FFV_{Trad} and FFV_{Mod}) representing different supply

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[1] Food away from home is prepared food and eating outside. Food at home is fresh and preserved food which respondents purchase for cooking at home eg. fresh fruits and vegetables, meat, rice and diary products, etc.

chain related attributes. Thus, in the second stage of each attribute in food at home sub-demand system consists of 8 sub-category food commodities. Three types of attribute in food at home sub-demand system are considered here, namely, safety and quality indications, place of purchase and minimally processed attribute. The approximated LAIDS is applied to estimate within group expenditure and conditional own-price elasticities for aggregate and disaggregate items at the second stage budgeting. The unit value is used as a proxy of commodity price in demand system models (Lippe *et al.,* 2010) Missing values because of zero consumption have been replaced by district average weighted by household expenditure. Likewise, all aggregate and disaggregate food item prices will be examined for correlation structure in order to select the appropriate Price Index. In addition, individual households' characteristic variables are incorporated into the LAIDS models by translating function as it preserves the linearity of the system (Pollak and Wales, 1981).

To account for the problem arising from censored data, we employ the approach proposed by Shonkwiler and Yen (1999), which is frequently cited (see Ecker, 2008; Yen and Lin, 2006; Shiptsova, Goodwin, and Holcomb, 2004; Pittman, 2004; Yen, Kan, and Su, 2002; Su and Yen, 2000). The step of analysis starts with latent equation; first, define d_{ih} equal to 1 if household *h* consumes food item *i* and 0 otherwise and estimate the following equation:

$$d_{ih} = z_{ih}^{'} \alpha + v_{ih} \tag{1}$$

where $z_{ih}^{'}$ denotes a vector of socio-demographic variables. This equation is constructed using a probit model with v_{ih} is an error terms which assumed to be normally distributed. $\phi(z_{i}^{'} \hat{\alpha}_{i})$, a univariate standard normal probability function, and $\Phi(z_{i}^{'} \hat{\alpha})$ denoting the associated cumulative distribution function are formed using the estimated parameters from Equation 1. The second step involves transforming the original estimation equation yields the study LAIDS model for disaggregate food demand model.

$$w_{ih} = \Phi(z_{i}^{'} \hat{\alpha})[\alpha_{i}^{*} + \sum_{j=1}^{n} \gamma_{ij} \log p_{jh} + \beta_{i} \log\left(\frac{x_{h}}{P_{h}^{*}}\right) + \sum_{r=1}^{n} \delta_{ir} \eta_{rh}] + \varphi_{i} \phi(z_{i}^{'} \hat{\alpha}_{i}) + \xi_{i} \tag{2}$$

where $\alpha_{i} = \alpha_{i}^{*} + \sum_{r=1}^{n} \delta_{ir} \eta_{rh}$, w_{ih} is budget share for food item *i* expressed as a ratio of food at home expenditure. p_{jh} is the price of food item *j*. $\frac{x_{h}}{P_{h}^{*}}$ is the annual per capita food at home expenditure deflated by price Index. P_{h}^{*} is the selected price index. ξ_{i} is an error term and

α_i, γ_{ij}, β_i, δ_i and φ_i are parameters to be estimated and η denotes the vector of household characteristics.

In the demand system equations, the error terms across equations are correlated by the fact that the dependent variables need to satisfy the budget constraint. Therefore, both budgeting stages will be estimated with the Seemingly Unrelated Regression (SUR) developed by Zellner (1962). In the process of estimation at the second stage budgeting, symmetry and homogeneity conditions across equations are imposed, following Pittman (2004). The simultaneous system contains seven demand equations, as one (OPF share equation) has to be dropped from the system to preserve the adding-up restriction. In addition, the error terms are heteroskedastic consequently the covariance matrix of second-step estimator is incorrect. Bootstrapping estimation is used for inferences about the estimated parameters (Alfonzo and Peterson, 2006; Su and Yen, 2000).

Data

The household survey in urban areas of Bangkok and Chiang Mai was conducted employing a multi-stage sampling design. At the first stage, six districts in Bangkok and two districts and four sub-districts in Chiang Mai were randomly chosen. At the second stage, five residential roads were randomly selected from each district or sub-district. Finally, households along these roads were selected by systematic ranking. This procedure allowed us to obtain a representative sample in the absence of recent census data. In total, 500 households were interviewed, 300 in Bangkok and 200 in Chiang Mai. The survey was conducted from April to July 2007; the primary food purchaser or the household head was interviewed. Respondents were asked to give information concerning consumption expenditures of food at home, food away from home and non-food items. Additionally, the specific quality attributes, namely, "place of purchase", "convenience attribute" and "food safety indications", were included for fresh fruits & vegetables. The questions also considered the consumer attitude toward quality and safety issues.

The annual per capita household expenditure is used as a proxy of permanent household income; the average was 110,934 baht (3,220 US dollars). Apart from economic determinants like income and prices, household characteristics are also expected to impact on consumers' behavior. Selected household characteristics included in the probit decision and disaggregate demand

model are presented in Appendix Table 1. The educational level of household heads is measured in years of schooling. Education is expected to positively impact on demand for fresh produce with specific quality attributes. The participation of women in the workforce is included as a dummy variable which would be expected to impact on demand as a consequence of increasing opportunity costs of time. Other household characteristics like household size, age of household head and their occupation are included in the models. The differences between two provinces are captured by a dummy variable with Chiang Mai as a reference. Additionally, attitudes of consumers are assessed by generating their degree of agreement to certain statements. A dummy variable for consumers who agree that quality and safety of FFV are sufficiently guaranteed only in modern retail outlets and specific shops (attitude 1) is included in the sub-system of place of purchase, expecting to have a positive impact of the share of FFV from modern retailers. Another dummy variable of consumers who are seriously concerned with preparing FFV such as washing (attitude 2) is included in the sub-system of convenience, expecting to decrease in demand of minimally processed fresh produce.

Results and Discussion

This section describes the consumption patterns for fresh fruits & vegetables including consumers' attitude towards safety and quality attributes. This is followed by demand estimation and elasticities. The last sub-section presents the projected demand for fresh fruits & vegetables from modern supply sectors.

Consumption Patterns for Fresh Fruits & Vegetables

This sub-section presents the expenditure share and quantity consumption for disaggregate fresh produce categorized into three groups. All figures are disaggregated by expenditure quartile[2] representing 25 percent of household sampling in each quartile and educational level of household head (Table 1). The share of disaggregate FFV is calculated as a ratio of group expenditure to total food at home expenditure. The average per capita consumption is derived from the annual data. As expected, FFV is mainly purchased in traditional retail outlets such as fresh markets and

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[2] Expenditure is used as a proxy for permanent household income. To generate the household income group, total per capita household expenditure was assigned to expenditure quartiles, contain 125 households (25 percent of total sample) each.

street stores. The expenditure share of purchased FFV from traditional retailers is 0.25 and moderately decreases from the poorest to the richest quartile. Conversely, modern retailers are of minor importance for fresh fruits & vegetables so far, with an expenditure share of 0.05, moderately increasing from lower to higher quartiles. Likewise, purchased quantity of FFV from modern retail outlets showed a difference by a factor of five between the poorest and richest quartiles. By considering safety and quality indications, the expenditure share clearly shows that direct observable informal indications[3] were ranked as the most important selection factor in the purchase of fresh produce. On the other hand, fresh produce with formal indications play a subordinate role, with a slightly increasing share from lower to higher expenditure quartiles. We also investigated expenditure shares and preferences for minimally processed fresh produce. The expenditure shares of fresh produce with and without minimally processing are somewhat similar. The difference in the share of minimally processed fresh produce between expenditure quartiles is slight. This could be explained by the fact that fresh-cut produce have increased in volumes in both traditional markets and modern retail outlets (Rattanapanone *et al.,* 2000), with prices that are affordable to poorer households.

Table 1 Budget share and annual average per capita consumption of disaggregate fruit and vegetable by expenditure quartile and educational level of household head

Supply chain related attributes		Entire samples	Expenditure quartiles				Educational levels	
			Q1	Q2	Q3	Q4	Edu1	Edu2
Place of purchase	Traditional retailers							
	Budget share	0.25	0.28	0.28	0.24	0.21	0.26	0.22
	Quantity (kilogram)	183.2	136.5	207.9	167.5	221.1	197.6	144.8
	Modern retailers							
	Budget share	0.05	0.03	0.04	0.05	0.08	0.03	0.09
	Quantity (kilogram)	28.6	10.8	18.2	31.3	54.1	22.7	44.3

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[3] For fresh produce, it is not easy to identify the safety of product at purchase. Hence, consumers generally rely on direct searchable indicators such as freshness, appearance, labels and brand names in their purchasing of fruits and vegetables (Mergenthaler *et al.,* 2009). In this study, direct observable informal indicators are the term of freshness and appearance, while formal indicators are food safety labels, certifications and brand names.

Table 1 (Continued)

Supply chain related attributes		Entire samples	Expenditure quartiles				Educational levels	
			Q1	Q2	Q3	Q4	Edu1	Edu2
Safety and quality indications	Informal indications							
	Budget share	0.23	0.24	0.24	0.23	0.21	0.23	0.23
	Quantity (kilogram)	166.8	117.7	182.2	156.1	211.3	177.7	137.7
	Formal indications							
	Budget share	0.02	0.01	0.02	0.02	0.03	0.02	0.03
	Quantity (kilogram)	10.6	4.3	9.3	13.0	15.7	8.7	15.7
Convenience attribute	Non minimally processed							
	Budget share	0.14	0.15	0.16	0.14	0.13	0.15	0.13
	Quantity (kilogram)	113.26	76.05	130.89	105.66	140.45	120.6	93.6
	Minimally processed							
	Budget share	0.16	0.15	0.15	0.16	0.17	0.15	0.18
	Quantity (kilogram)	103.55	72.84	96.68	100.49	144.18	102.5	106.4

Note: The budget share is a ratio of disaggregate item expenditure on total food at home expenditure. Edu1 and Edu2 denote the group of household heads who have the undergraduate and graduate or above educational levels, respectively.

Source: Calculated from household survey data

Furthermore, higher educated consumers tend to be more open-minded in their food selection and quickly adopt new varieties of foods (Senauer, Asp, and Kinsey, 1993). These consumer groups are expected to have more knowledge and a higher awareness of food safety and quality aspects. In our context, household heads are assumed to have the major decision or a heavy influence on household food purchases. They were interviewed to provide information on their education level, which was categorized into two major groups namely undergraduate educational level "Edu1" and graduate educational level or above "Edu2". The expenditure share and consumed quantities of purchased FFV from modern retail outlets increased with higher educational level of household heads. This result would be in line with the observations that modern retailers have penetrated the higher educated and younger consumer groups (Gorton *et al.,* 2009). The positive relation between increasing consumption of fresh produce with formal indications reflects the higher safety concern among better-educated consumers. The share of fresh produce encompassing minimally processed steps slightly increased within the higher educational level of household heads, likely a reflection also of the value of time.

Attitude toward Safety and Quality Attributes

In order to get additional information on consumers' attitudes, the respondents were asked questions concerning safety and quality attributes. Consistent with previous findings by the National Statistical Office (2005), most of the respondents (99 percent) agreed that consuming fresh fruits & vegetables is healthy. Consumers are now more confident to consume FFV from traditional fresh market compared to five years ago (42 percent), reflecting the improving standards as a result of public sector interventions in the market system. Nonetheless, a high proportion of households (41 percent) also agreed that quality and safe FFV are available only in supermarkets or specialty shops. Most respondents also agreed that controlling the production processes could sustain a higher confidence in consuming FFV (87 percent). This was suggested that the Thai government agencies should focus their efforts and funding to support farmers and producers in strictly controlling the production system (94 percent).

Attitudes to safety and quality certificates were also assessed. Various certificate logos exist and are usually presented on a specific product package. Four widely applied certification labels were used to ask respondents about their confidence in FFV with these labels. The "Safety Food" (issued by the Ministry of Public Health), the "Q" sign (issued by the National Bureau of Agricultural Commodity and Food Standards), "Organic Thailand" (issued by the Department of Agriculture) and "ACT" (an organic label accredited internationally by IFOAM) were considered. More than 70 percent of respondents trust government certificates and show a higher preference to produce with government labels over private certifications. This confirms the findings of Vanit-Anunchai and Schmidt (2006) that Thai consumers prefer the government certificate in regulating food safety. Most respondents (89 percent) have confidence in fresh produce with the Doi-Kham brand from the Royal Project Foundation. The high percentage could be explained by a rather strict product safety control supply chain system of Doi-Kham before distributing the food products to marketing agents and end consumers (Isvilanonda *et al.,* 2006). In contrast, our study found that private brands and logos only showed a consumers' confidence of 47 percent.

Disaggregate Demand System Estimation

As described above, the analysis started with the first budgeting stage in order to estimate the food at home expenditure elasticity. The second stage focused on the disaggregate FFV of each

supply chain- related attribute. The parameters which form the Working-Leser Model for broad group item at the first budgeting stage and the group expenditure elasticities are described in Lippe *et al.* (2010). By considering the disaggregate demand part, aggregate FFV is replaced by sub-categories representing different supply chain-related attributes. The LAIDS with two-step procedures are employed in the second budgeting stage. The probit models on decision to purchase for infrequency consumed items are estimated for all sub-system, as depicted in Appendix Table 2. The estimated coefficients from LAIDS models for the disaggregate commodities within the food at home group are presented in Appendix Table 3. All the expenditure share equations are statistically significant at 5 percent significant level according to chi-square test. The logarithm terms of per capita food at home expenditure has different levels of statistical significance from zero in the case of "place of purchase" and "non-minimally processed' FFV at least at 10 percent significant level. These coefficients have a negative sign for FFV from traditional supply sectors and positive sign for FFV from emerging modern supply sectors. It suggests that urban households in Bangkok and Chiang Mai tend to consume more FFV from modern supply sectors if expenditure level increases. Most own-price coefficients are also statistically significant at least at 10 percent significant level. The non-significance of own-price parameters can be the result of less variation of food prices, particularly for products which are consumed by few households during the survey period. In that sense, missing price values are more imputed by average weighted market price from each district.

Besides expenditure levels and prices, household composition variables were included to account for the influence of demographic factors. Household size has a significantly negative impact on the expenditure share of purchased FFV from traditional supply sectors, reflecting the decreasing FFV share by this sector as household size increases. It could be explained that in a larger households the share of young people and their influence on purchase decisions increase by preferring FFV from modern supply chains. The estimated coefficients for educational level of household heads are positive and highly statistically significant for purchased FFV from modern retail outlets, FFV with formal labels, and minimally processed FFV. The results are in line with the assumption that better-educated household heads tend to spend more on FFV with additional safety and quality attributes. Geographic location dummy is statistically significant in most cases except safety and quality indications and modern retail outlets. However, the positive sign of location

dummy variable for all cases of FFV from emerging supply sectors reflects the different levels of development of the modern retail sectors in Bangkok and Chiang Mai. Bangkok's food retail sector is more advanced than Chiang Mai with respect to the density of modern retail outlets. The coefficient of household head's age has a significantly positive impact on the share of purchased FFV from traditional retailers, FFV with informal indications and minimally processed FFV. This indicates that the older household heads still purchase fresh produce from the traditional retailers using appearance and freshness as the most important criteria. Likewise, older consumers tend to spend more on minimally processed FFV likely for convenience; they need not spend time for preparation. Dummy variables for various attitudes about food were further included in the LAIDS estimation. As expected, the attitude dummy variable for consumers agreeing that safety and quality FFV are assured only in supermarkets and specialty stores (attitude 1) has a significantly positive impact on the share of purchased FFV from modern retail outlets. Household respondents who carefully clean fresh produce (attitude 2) have a high demand for non-minimally processed FFV, thus reversing the declining share of minimally processed FFV. This pattern can be explained by the inclusion of fresh produce from open air markets into the sub-category of minimally processed FFV perceived as not safe by some consumers.

Disaggregate Demand Elasticities

As outlined above, the main objective is to estimate disaggregate demand elasticities, reflecting consumption behavior particularly on fresh fruits & vegetables. All within group elasticities are calculated based on the formulae provided by Green and Alston (1990). The disaggregate demand elasticities with respect to continuous variables are presented in Table 2. All point estimates of within group expenditure elasticities indicate a one percent increase in food at home expenditures stating an over proportionately increase in demand for FFV from emerging modern supply sectors. The estimated unconditional expenditure (income) elasticities for each disaggregate items are calculated by corresponding conditional expenditure elasticity of disaggregate FFV multiplied by food at home expenditure elasticity at the first budgeting stage (0.52). All income elasticities are smaller than one, indicating that they are normal goods. However, the demand responsiveness with respect to income among the different supply chain-related attributes is within the expected range. Income elasticities for FFV from modern supply sectors are higher than those from traditional

ones, suggesting an increase in the consumption of safe and quality fruits & vegetables as household income increases. The conditional own-price elasticity of FFV from modern retail outlets is being the case of elastic demand and almost elastic for FFV with safety labels and minimally processed FFV. In comparison, consumers are more sensitive to price changes in purchased FFV from modern retailers, minimally processed FFV, and FFV with formal indications.

Table 2 Disaggregate demand elasticities for fresh fruits & vegetables from different supply chain related attributes

Supply chains related attributes	Mean budget shares	Conditional expenditure elasticities	Unconditional expenditure elasticities	Conditional own-price elasticities	Conditional education elasticities
Places of purchase					
Traditional retailers	0.25	0.77	0.40	-0.65	-0.09
Modern retailers	0.05	1.35	0.70	-1.10	1.19
Safety and quality indications					
Informal indicators	0.23	0.97	0.51	-0.61	0.01
Formal indicators	0.02	1.18	0.61	-0.94	1.83
Convenience attributes					
Non minimally processed	0.14	0.70	0.36	-0.55	-0.04
Minimally processed	0.16	1.10	0.57	-0.81	0.16

Source: Estimated based on household survey data.

The level of educational attainment of household head influences demand for FFV from emerging supply chain sectors. The education elasticities are calculated for each attribute using the estimated coefficients and mean budget shares, yielding some useful insights. The education elasticities indicate that education significantly influences demand for purchased FFV from modern retail outlets, FFV with formal indications and minimally processed FFV. Education may have an influence on the lifestyle of consumers that in turn induces change in consumers' preferences. This result is much in line with the observation that the improving education standard in Thailand has impacted on the awareness of food safety and quality as in more developed countries (Kanlayanarat and McGlasson, 2003).

In accordance with the few studies on disaggregate demand estimation from different supply chain-related attributes; our findings are compared to the results of a recent study in Vietnam

(Mergenthaler *et al.,* 2009).[4] Our income elasticities for disaggregate FFV are different from those obtained by the Vietnamese study, particularly for FFV from modern retail outlets. This fact is explained by the distinct demand responses between "low- and middle income countries" there is a high responsiveness to income change in low-income countries (Seale, Regmi, and Bernstein, 2003). On the other hand, high income urban households may still purchase FFV from traditional market as they are now more confident of the attributes of produce now being sold in these outlets than five years ago. Moreover, FFV with specific quality attributes like fresh-cut fruits and pesticide-free vegetables are more easily found in Thai domestic markets. Their wide availability is induced by middle class households that demand and can afford such products.

Projected Demand

The estimated demand elasticities based on significant effects of continuous variables are used to derive demand growth factors in order to project demand for FFV over the next ten years. Special product attributes are considered to project demand, namely, purchased FFV from modern retail outlets, minimally processed FFV, and FFV with formal indications. For our projections, we take into account the income levels, educational attainment of household head and product price. The following formula[5] is used to calculate the growth factor projection.

$$\hat{G}_i = [\varepsilon_I * (\hat{G}_{inc} - POP)] + (\varepsilon_{edu} * \hat{G}_{edu}) + (\varepsilon_P * \hat{G}_{price}) + POP \tag{3}$$

where $\hat{G}_i$ denotes growth of FFV demand from modern supply sectors (modern retail outlets, formal indications and minimally processed). ε_I, ε_{edu} and ε_P are income, education and own-price elasticities, respectively. $\hat{G}_{inc}$, $\hat{G}_{edu}$ and $\hat{G}_{price}$ are growth of real income, education years, and own-price, respectively. POP is growth of population growth.

The growth of GDP is used as a proxy of growth rate for real income, while the change in price is based on the annual price dataset for major consumed fruits & vegetables at the biggest wholesale market in Bangkok "Talad Thai". In order to estimate the difference in consumption patterns in different economic situations, the growth rate is set into three scenarios with changes

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[4] Expenditure elasticities range between 1.2 and 2.6, while own-price elasticities were found to be between -1.5 and -1.1 for safety and quality assurances, modern retail outlets and imported produce, respectively.

[5] Because of the significance level, the own-price elasticity and growth of own price is applied only in the case of demand projection for minimally processed FFV.

in income and price. Scenario A is normal economic growth in which GDP will grow by 8 percent and prices increase by 6 percent. Scenario B is economic recession resulting in a slight growth in GDP of 4 percent and an increase in prices by 9 percent. Scenario C is a high growth, with GDP as well as prices increasing by 12 percent. To eliminate the influence of population growth on GDP, this variable is included into the growth demand factor model. The forecast of population trend from the National Economic and Social Development Board year 2007 shows an expansion 0.82 percent during the year of projection. Based on the policy of the Office of Education Council, an increase in education years by 2.9 percent is expected.[6] According to our household survey data, the average years of educational attainment would increase from 10.2 in 2007 to an average of around 12.8 in 2017.

The growth factor projection $(\hat{G}_i)$ is used to calculate the purchased quantity for FFV from different modern supply chain-related attributes over the next ten years from different scenarios, ceteris paribus. The quantity of FFV purchased from modern retail outlets is expected to slightly increase from 29 to 65 kilograms in a normal economic growth scenario; to 50 kilograms in a recession scenario; and to 102 kilograms per capita per year in a high economic growth scenario (Figure 2). Demand for FFV with formal indicators is likely to increase three-fold to 37 kilograms per capita per year in a high economic growth situation (Figure 3). The demand for minimally processed FFV is projected to decline from 104 to 69 kilograms per capita per year in a recession scenario. This is because the projected demand for this disaggregate item is driven more by price than any other factor, especially when the economy is in a period of slow growth. It slightly increases to 108 in a normal economic growth and 115 kilograms in a high economic growth scenario (Figure 4). Overall, the projected demand for FFV from emerging supply chains-related attributes is likely to increase with increasing household income and higher educational level of the household head (or the purchase decision maker). These demand forecasts under three different scenarios of growth suggest a trend in which demand for FFV with specific quality attributes would grow in the medium- or long-run period in the urban areas of Thailand.

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[6] The Office of Education Council reported that the expected years of schooling for the Thai population as a whole are 10 and 13 years in 2011 and 2026, respectively. The average year of educational attainment of Thais in 2005 was 8.52 years.
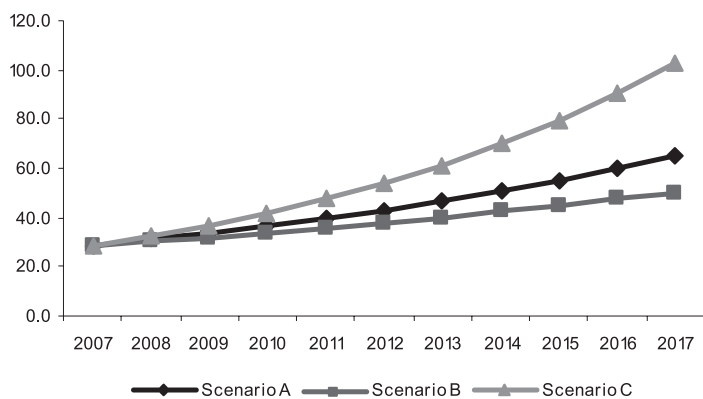
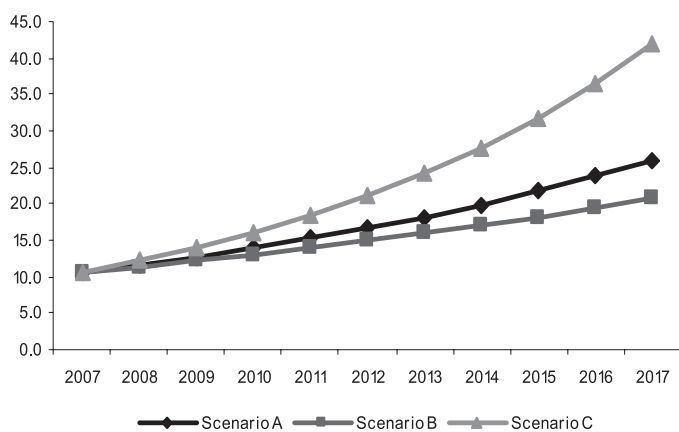**Figure 2** Projected demand for purchased FFV from modern retailers

Figure 3 Projected demand for purchased FFV with formal indications
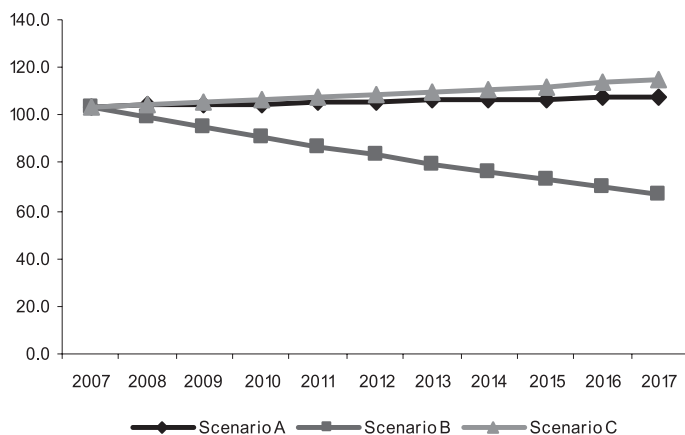

Figure 4 Projected demand for purchased minimally processes FFV

Conclusion and Recommendations

In the light of wide ranging and profound transformations in the food sector, an understanding of consumption behavior is a crucial prerequisite for local supply chain actors to develop effective strategies to meet changing demand patterns. It is also an important guide for the design of food and agricultural policies. So far demand analysis, particularly for fresh fruits & vegetables with specific quality attributes, has received relatively little attention in Thai research. This study fills this research gap by estimating the disaggregate demand parameters for fresh fruits & vegetables that have different product- and process-related attributes. We employed a two-stage budgeting framework to project the demand for fresh produce from emerging supply chain sectors. The data were obtained through a comprehensive household survey of urban areas in Bangkok and Chiang Mai. The focus was on the role of modern retail outlets, convenience attributes, and fresh produce with formal indications of safety and quality attributes.

Consumers' decision to purchase fresh produce from modern retailers and minimally processed FFV are significantly influenced by total household expenditure and educational levels of household heads. The influence of safety and quality indications (ie. logos, brands and labels) on purchase decision is significantly related with the educational levels of household heads; this suggests that higher educated buyers give more attention to product safety and quality attributes when deciding to buy. Overall, the estimated demand elasticities from this study conform with expectations: in a growing economy, in which economic development accelerates such social improvements as better education, the trend in domestic demand for fresh produce is towards an increasing emphasis on food safety, quality and convenience attributes.

The significant difference between unconditional expenditure elasticities of fresh produce from traditional and emerging supply chain-related attributes suggests that the food sectors as a whole should quickly adapt to such a change in consumers' preferences. The finding that Thai consumers still mainly purchase fresh produce in the traditional markets because they now have more confidence in the quality attributes of products from these markets than they had five years ago is a useful information for traditional retailers. They could build on this new-found strength to win customers' trust by developing safety and quality standards and upgrading fresh produce to strengthen their competitiveness. Traditional markets could increase the market share of minimally processed fresh fruits & vegetables by, at the very least, observing standard sanitary

conditions usually applies to processed food. The modern retailers, on the other hand, should sustain their reputation for quality products, and improve their product lines with premium standards to reach consumers in the higher class segments. Efficiency gains through economy of scale and with various cost-efficient strategies and practices enable modern retailers to reduce prices; this would result in a disproportionate increase in the demand for fresh produce from modern retail outlets. Social and economic development, abetted by policies that foster income growth and better education, and encourage healthy competition in the food agribusiness sector, will promote the production and supply of better quality products and further dietary diversification. Support for further studies of both supply and demand sides is necessary to design efficient policies for food system transformation.

This study can serve as a guideline for consumers' analysis of other agricultural food products. Further research on consumption behavior for fresh produce with other quality aspects is also needed to increase our understanding of market dynamics as influenced by consumer behavior. As to the scope of a further study, a wider variation of consumer groups, a wider geographical scope covering more locations, and greater sample size from each group would be required for a highly disaggregated demand analysis.

Acknowledgements

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Appendices

Appendix Table 1 Household composition by expenditure quartiles

Variables	Definitions	Entire samples	Poorest quartile	Richest quartile
TE	Annual per capita total household expenditure	110,934.50	40,214.19	236,221.20
FAH	Annual per capita food at home expenditure	19,783.48	12,074.55	28,811.50
Size	Household size (persons)	4.3	5.2	3.8
Age	Age (years)	49.2	50.5	44.8
Education	Years of education	10.2	8.0	12.8
Female labor	Dummy for female participation in labor force (%)	53.4	52.8	51.2
White collar	Dummy for white collar jobs (%)	14.2	9.6	21.6
Workers	Dummy for workers or entrepreneurs (%)	39.6	36.8	40.0
Housewife	Dummy for housewives (%)	46.2	53.6	38.4
Distance 1	Distance to the traditional market (km.)	1.8	1.6	2.1
Distance 2	Distance to the supermarket (km.)	2.6	2.5	3.1
Health	Consuming FV is useful for health (%)	99	97.6	99.2
Attitude 1	Quality & safety FV are only in the modern retailers (%)	41.2	36.8	52.8
Attitude 2	Consumers seriously concern washing FV (%)	64.6	64.8	65.6
Media	Number of media use	3.1	3.0	3.4
Awareness	Dummy of awareness of health problems linked to food quality (%)	93.4	91.2	96.8
Disease	Dummy for household members being affected by long-term diseases (%)	41.0	41.6	36.8

Source: Calculated based on household survey data.

Appendix Table 2 Probit estimation of the decision to purchase disaggregate fresh fruits & vegetables of food at home

Variables	Places of purchase		Safety and quality indications		Convenience attributes	
	Traditional retailers	Modern retailers	Informal indicators	Formal indicators	Non minimally processed	Minimally processed
Total Expenditure (log)	-0.2832	0.3440**	0.4996**	0.0256	0.0061	-0.2450**
	[0.1871]	[0.1599]	[0.2521]	[0.2323]	[0.1171]	[0.1217]
Price-traditional FFV (log)	0.5115	-0.0826	1.0386***	0.2958	0.5324**	-0.3661
	[0.3817]	[0.1917]	[0.2798]	[0.2198]	[0.2192]	[0.2509]
Price-high value FFV (log)	0.3165	0.1191	-0.6565***	0.0512	0.2866*	0.6359**
	[0.1966]	[0.1599]	[0.2259]	[0.2351]	[0.1605]	[0.2525]
Size (log)	-0.1935	0.0844	-0.2596	0.0316	0.0535	-0.0383
	[0.1968]	[0.1300]	[0.1909]	[0.1427]	[0.1650]	[0.1766]
Female labor	-0.3279	0.2658**	-0.1747	-0.0048	-0.1199	-0.1774
	[0.2260]	[0.1290]	[0.1869]	[0.1491]	[0.1846]	[0.2118]
Education year	-0.0542**	0.0530***	-0.0323	0.0215	-0.0436**	0.0259
	[0.0261]	[0.0141]	[0.0244]	[0.0160]	[0.0208]	[0.0220]
White collar	0.6732	-0.3823**	0.6395*	-0.6498***	0.1111	-0.2072
	[0.4252]	[0.1934]	[0.3378]	[0.2401]	[0.2828]	[0.3151]
Workers	0.5751**	-0.5976***	0.0066	-0.3250**	-0.0057	-0.2319
	[0.2594]	[0.1416]	[0.1956]	[0.1606]	[0.1978]	[0.2267]
Distance 1	-0.0665**	0.0085	-0.0520	0.0140	-0.0524	-0.0019
	[0.0300]	[0.0258]	[0.0345]	[0.0232]	[0.0336]	[0.0407]
Awareness	-0.0776	-0.1625	0.7007**	0.4892	-0.0238	0.7855***
	[0.4802]	[0.2588]	[0.2790]	[0.3518]	[0.3458]	[0.2803]
Bangkok	-0.5631**	0.3265**	0.5319**	-0.1136	-0.0729	-0.4443*
	[0.2853]	[0.1459]	[0.2072]	[0.1640]	[0.1770]	[0.2615]
Diseases	0.0161	0.2955**	0.3044	0.1543	0.1326	0.1402
	[0.2199]	[0.1255]	[0.2045]	[0.1389]	[0.1736]	[0.1965]
Constant	7.3162***	-6.3327***	-8.3655***	-6.3684***	2.1986	-0.6061
	[2.5603]	[1.7863]	[3.1538]	[2.2262]	[2.0779]	[2.4518]
Log likelihood	-72.76	-285.94	-108.89	-223.08	-141.05	-99.09
Chi-square	50.56	71.37	68.05	44.71	36.26	60.44
Household zero consumption	22	318	47	401	47	32

Source: Estimated based on household survey data.

Note: *, **, *** represent the statistical significance at 10%, 5% and 1% levels, respectively. Numbers in parentheses are robust standard errors. All cross prices were included as independent variables, but they are not presented here for reason of space.

Appendix Table 3 Conditional disaggregate demand system estimates for FFV from different supply chains relatedattributes

Variables	Place of purchase		Safety & quality indication		Convenience attribute	
	Traditional retailers	Modern retailers	Informal indictors	Formal indicators	Non minimally processed	Minimally processed
FAH expenditure (log)	-0.0573***	0.0170**	-0.0067	0.0037	-0.0436***	0.0162
	[0.0160]	[0.0075]	[0.0107]	[0.0032]	[0.0123]	[0.0109]
Price-traditional FFV (log)	0.0720***	-0.0025	0.0883***	-0.0191**	0.0589***	-0.0039
	[0.0172]	[0.0155]	[0.0164]	[0.0096]	[0.0133]	[0.0106]
Price-high value FFV (log)	-0.001	-0.0040	-0.0042**	0.0014	-0.004	0.0321**
	[0.0058]	[0.0092]	[0.0021]	[0.0056]	[0.0109]	[0.0132]
Size (log)	-0.0775***	-0.0030	-0.0297***	0.001	-0.0605***	-0.0165
	[0.0161]	[0.0085]	[0.0106]	[0.0034]	[0.0122]	[0.0117]
Education years	-0.0023*	0.0057***	0.0001	0.0038*	-0.0006	0.0025**
	[0.0014]	[0.0022]	[0.0012]	[0.0020]	[0.0013]	[0.0012]
Female labor	-0.0103	0.0040	-	-	-	-
	[0.0136]	[0.0230]	-	-	-	-
Bangkok	-0.0366***	0.0065	-0.0040	0.0261	-0.0418***	0.0315***
	[0.0133]	[0.0275]	[0.0133]	[0.0315]	[0.0118]	[0.0109]
Age	0.0008**	0.0002	0.0011**	-0.0003	0.0005	0.0006*
	[0.0004]	[0.0007]	[0.0004]	[0.0006]	[0.0004]	[0.0004]
Distance 2	-0.0037	0.0083	-0.0021	0.0032	-	-
	[0.0027]	[0.0054]	[0.0022]	[0.0068]	-	-
Number of media	0.0033	-0.0140*	-	-	-	-
	[0.0047]	[0.0077]	-	-	-	-
Attitude	-0.0230**	0.0851***	-	-	0.0232*	-0.0285**
	[0.0111]	[0.0248]	-	-	[0.0126]	[0.0111]
White collar	-0.0099	-0.0415	0.0161	-0.0563	-0.0172	-0.0032
	[0.0211]	[0.0368]	[0.0172]	[0.0481]	[0.0175]	[0.0170]
Workers	0.0108	-0.0159	0.0188	-0.0600*	0.0021	-0.0011
	[0.0160]	[0.0345]	[0.0138]	[0.0335]	[0.0141]	[0.0140]
Probability function	-0.2047**	-0.0381	-0.0327	0.0483	-0.1705**	-0.1243**
	[0.0904]	[0.0950]	[0.0552]	[0.0743]	[0.0786]	[0.0624]
Constant	0.9992***	-0.1304***	0.3613***	-0.0435	0.7038***	0.0011
	[0.1656]	[0.0489]	[0.1026]	[0.0272]	[0.1356]	[0.1126]
Chi2	135.09	110.80	101.33	50.87	109.89	67.97

Source: Estimated based on household survey data.

Note: *, **, *** represent the statistical significance at 10%, 5% and 1% levels, respectively. Numbers in parentheses are bootstrap standard errors. MP denotes minimally processes. All cross prices were included as independent variables, but they are not presented here for reason of space. Attitude in sub-demand for place of purchase is attitude 1, while attitude 2 was included in sub-demand for convenience attributes.